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ABSTRACT

A systems model offers an orderly way of identifying and evaluating the complex components and relationships that are present in special education systems. When applied to national or local systems of special education, it is possible to derive convenient profiles of their strengths and weaknesses, and thus to generate future improvements. As well as having utility at this macroscopic level, the model can also be applied to the planning of single pieces of action research and to individual case work. (Author/SBH)

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A SYSTEMS APPROACH TO DESIGNING AND EVALUATING SPECIAL EDUCATION

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A SYSTMES APPROACH TO DESIGNING AND EVALUATING SPECIAL EDUCATION[1]

David R. Mitchell

A paper presented to the World Congress on Future Special Education, Stirling University, Scotland, 25 June - July 1978

> Systems thinking in education serves as a constant reminder that everything is interrelated with everything else, and that it is dangerous to neglect this interdependency.
>
> (CERI, 1971, p.39)

A systems model offers an orderly way of identifying and evaluating the complex of components and relationships that are present in systems that have a significant degree of unity (Cooley and Hummel, 1969; Daniels and Yeates, 1971; Hartley, 1968; Mitchell, 1975). With their origins in sicence and technology, systems procedures, or "systems analogous" procedures (CERI, 1971, p. 40) are increasingly being applied to the design, implementation, and evaluation of educational enterprises. These range from the macroscopic level of educational organization and administration (Lerner and James, 1973; Mitchel, 1975; UNESCO, 1975), to such specific areas as counseling (Ryan, 1969; Stewart et al, 1978), curriculum (Freyberg and Osborne, 1976), educational technology (Eriksson, 1969), course planning (Jamison and McLeod - Guertin. 1969), and the teaching-learning process (Lerner, 1973; Lerner and James, 1973).

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[1]Some of the material in this paper has been adapted from Mitchell (1975).

In this paper, a system will be defined, an overview of various types of systems and of systems analysis provedures will presented, and the utility of a systems approach to various aspects of special education will be discussed. Illustrative examples will be drawn in the main from New Zealand.

What is a System?

The basic thesis of a systems approach is that an understanding of the function and importance of a component or activity can best be drrived from a knowledge of the whole system of which it is a part. Or, as Ackoff and Emery (1972, p.5) express it, "today we increasingly tend to derive our understanding of the structure of the parts of the system from an understanding of the functioning of the whole." This leads us directly to a consideration of the three characteristics commonly assigned to social systems - wholeness, connectedness and goal seeking.

Wholeness.

All writers conceive of a system as comprising a whole. Their use of phrases such as 'set of interrelated elements' (Ackoff and Emery, 1972, p. 18), 'a universe of interest' (Systems Development Corporation, 1970, p.2), 'holistic orientation' (Van Court Hare, 1967, p.4), and 'a unity with specific boundaries' (Steward et al, 1978, p.22) conveys their concern for studying the characteristics of the whole.

In relation to special education, questions such as the following arise with regard to wholeness:

(i) Are the health, education and welfare wervices provided for handicapped children part of the whole or are they separate, and even competing systems?

(ii) Are parents to be included in the system (Mitchell, 1977)?

(iii) Should the system include teacher educators and researchers in addition to practitioners and administrators?

Connectedness.

Obviously, for a set of elements to comprise a whole, they must be connected in some significant way. This second characteristic of systems has been expressed in such terms as 'elements standing in interaction' (Von Bertalanffy, 1968, p.9), ' a set of interacting elements' (White and Tauber, 1969, p.4), 'intricate interrelationships of parts' (Buckley, 1968, p. xvii), and 'an organization of relationships among the parts and the whole' (Steward et al, 1978, p.22). It is this characteristic of connectedness which helps clarify what is meant by the somewhat paradoxical claim that 'the whole is more than the sum of its parts'. This principle of non-summativity, as it is known, draws our attention to the products that occur as a result of the interactions between and among elements.

The notion of connectedness, when applied to an analysis of special education, suggests two important questions:

(i) What are the formal and informal relationships among the sub-systems and between them and the whole?

(ii) What mechanisms exists to facilitate optimal connectedness? Australia, for example has a National Advisory Council for the Handicapped which plays an important role in this respect.

Goal-seeking

When the notion of a system is considered in relation to distinctively human enterprises, the characteristics of wholeness and connectedness are usually supplemented by a third characteristic of goal-seeking. Phrases

This point must constantly be borne in mind, especially when considering complex entities such as education systems.

Systems, Subsystems, Suprasystems and Environments

Any given 'system' usually contains several 'subsystems' and is contained in turn within a larger 'suprasystems' and a 'total environment'. This notion of embededness throws into relief the difficult problem of determining boundaries, a problem made more complex by the tendency for some writers to use the terms system and subsystem interchangeable. The usual procedure, however, is for the term system to be employed when a structure is considered in some detail, the term subsystem referring to its subordinate structures. When one of the latter comes into focus, as it were, it is usually termed the system, the term subsystem being shifted to apply to its subordinate structures, while the original system is referred to as a suprasystem, and so on.

The notion of the environment also requires some clarification. Chadwick (1971, p. 43) defines it as "the set of systems other than the one in which we are interested." He points out that we are never interested in the elements of the environment; if we were, they would have to be included in the system. This distinction is not fully accepted by Bobbitt (1974, p. 213), however, who distinguishes between a 'general environment' and a 'relevant environment'. Unlike Chadwick, Bibbitt argues that the relevant environment can exercise a direct effect on the system without being considered an integral part of it. For the purposes of the present analysis, Bobbitt's distinction is accepted.

Taking these points together, it is suttested that special education can conveniently be considered as a subsystem of the education system which is,in turn, part of the suprasystem of child-oriented services

such as 'purposeful view' (Ackoff and Emery, 1972, p,5) and 'purposiveness, goal-seeking system behavior' (White and Tauber, 1969, p,4) suggest that systems exist to achieve certain objectives.

In these terms, we might ask the following questions about a special education system:

(i) What goals does it have? This issue is all too rarely examined, in New Zealand, for example, there has never been an analysis of special education comparable to the recently completed Warnock's Committee;s iniquiry in Great Britain.

(ii) Are the goals held by the sub-systems complementary or contradictory? There could be difficulties if, say, one sub-system (e, g., teachers) were geared towards sheltered placement, or vice versa.

(iii) Which children should the system aim to serve? In New Zealand, for example, gifted children do not receive special education and children with specific learning difficulties are not only just receiving recognition.

Taking these three points of wholeness, connectedness, and goal-seeking together, a definition of a system that would have wide acceptance is a set of interrelated elemeents operating together for a common purpose.

Before turning to a more detailed analysis of systems and their supra-and-sub systems, a caveat expressed by Lerner and James (1974, p.276) should be emphasized. In discussing the employment of systems models (also to elucidate special education), they were at pains to stress that while models can reduce complex systems to managemable propostions, thus serving to crystallize thinking and perception, they are essentially abstractions or idealizations and cannot replace the real world.

(health, welfare, etc.) provided in a modern society. Beyond that there is the relevant environment constituted by such community groups as employers, and the more general environment. Figure 1 portrays these relationships in diagrammatic form.

(Place Figure 1 near here)

Types of Systems

Systems may be classified in a variety of ways, but four dimensions seem particularly important when an education system is being considered. These are:

(i) simple vs complex,

(ii) deterministic vs probabilistic,

(iii) competitive vs non-competitive, and

(iv) open vs closed.

Simple vs Complex

Systems range from simple (e.g., a water cistern), through complex but describable (e.g., an electronic computer), to those which are so complex that they cannot be described in a precise or detailed manner (e.g., an economic system, an education system). The notion of complexity was graphically illustrated by Beer (1966) when he pointed out that in a system comprising only seven subsystems, there may be as many as 2^{42}, or over 1,000,000,000,000 different states if each of the elements is linked two ways with all other elements and each link may be 'on' or 'off'. As Chadwick (1971) points out, however, if we have to choose one state only of the system, this task can be handled in terms of 42 one-bit decisions, rather than in terms of 1,000,000,000,000 decisions.[1] There is, therefore, the possibility of control, even in complex systems.

[1] This principle is derived from information theory and is too complex to elaborate here.

Deterministic vs Probabilistic Systems

A deterministic system is one in which the parts interact in a perfectly predictable way, whereas a probabilistic system is one about which it is not possible to give a detailed prediction, the occurrence of events being defined only as probabilities. An example of the former is an electric light switch: the switch invariably activates the light (unless frequent power cuts make it a probabilistic system). Examples of a probabilistic system can be found in the behaviour of organisms such as man or of human enterprises such as an education system; one cannot predict their behaviour without a considerable margin of error. The longer term the prediction, the greater the degree of uncertainty. Blaugh (1967, p. 46), likened predictions such as those made in probabilistic systems to "a funnel that will widen into the future as the degree of uncertainty attaching to predictions increases".

Taking the two preceding classifications in combination, a four-fold typology of systems can be employed (Beer 1959): from simple deterministic systems to complex probabilistic systems, via simple probabilistic and complex probabilistic systems. A special education system (or sub-system) is best considered as a complex probabilistic system.

Competitive vs Non-competitive Systems

In situations where a system exists in the presence of one or more other systems and all have as one of their objectives the defeat or partial defeat of each other's system, we have a state of competition. An obvious example of this is provided by commercial organizations competing for the same set of customers. A monopoly would be an example of a non-competitive system. Insofar as a particular school system has a monopoly in the provision of schooling and school attendance is compulsory,

it could be said to be non-competitive. In New Zealand, for example, this is pretty much the case for the private school sector hardly constitutes a serious competitor to the state's special education provisions. Facilities provided by voluntary societies and by health and social welfare agencies tend to be complementary rather than competitive. In Australia, however, the situation is quite different, the private school system being much more competitive, and in some states there are overlapping services provided by voluntary bodies and various state agencies.

Open vs Closed

A system may be considered open or closed according to whether or not its boundaries are, respectively, permeable or impermeable to the exchange of information and other matter with its superordinate structure. This can be assessed by examining the quality of the transactions that exist between a system and its suprasystem and/or the relevant environment. As one writer has noted, however, since no actual system can ever be completely closed or isolated from its environment, the question is one of whether the system is *relatively* open or *relatively* closed (Miller, 1971, p. 282).

An open, or relatively open, system is said to be in a condition of "steady state" (Von Bertalanffy, 1968, p. 39) which means it is engaged in a continuous exchange of information with its suprasystem and/or the relevant environment. It is not only open to messages from outside itself but also responds to them. An example of an open system is the blood system of a healthy mammal in which various concentrations are maintained at a fairly constant level as a result of material constantly entering from and going into the environment. The closest one can come to a closed

system is in certain physical chemistry experiments in which a number of reactants are brought together in a sealed container.

This aspect of systems focuses our attention on the existence and quality of the communication channels along which information concerning changes in the environment can flow into the system and, as well, along which information relevant to changes in one part of the system can be transmitted to other parts. As a system and/or its suprasystem and relevant environment develop, this will require structural differentiation in order to transmit and process increasingly diverse information (Buckley, 1967, p. 50; Farrell, 1976, pp 62-63). Close attention to these issues can lead to the diagnosis of deficiencies within a system which may be rectified by various organizational changes. Ryan (1969, p. 10), for example, suggests that in a system where parts are only loosely tied together, replacement or retooling of system parts may be necessary. Relations among parts previously unrelated may have to be developed and new parts may have to be added to encourage the development of strong relationships to other parts of the system. The alternative is system decay.

System Variables

Systems are typically analysed in terms of four sets of variables (Easton, 1965).

Input Variables

Those events from the suprasystems and/or relevant environment that make demands or establish supports for a system to achieve certain objectives. Several questions arise regarding these variables: Is the system sufficiently o[illegible] to make for meaningful access? To what extent is understandable and actionable information sought by the system?

In New Zealand, at least, there is a paucity of good understandable information from the relevant environment as to which demands are placed upon the special education system. This is mainly because it has not been actively sought, although there are increasing attempts to do so. For this to be rectified, conscious attempts have to be made to provide ample formal and informal access to it. The danger of not doing so is that the system will become insensitive to the needs and expectations of the relevant environment. It is essential that it be as open a system as possible.

Supports sometimes fail to keep pace with demands in special education, particularly in situations such as New Zealand where there has been a rapid expansion of services in recent years (a growth rate of 63 percent in the number of children catered for between 1966 and 1976, compared with a 15 percent growth rate in the normal school roll). This becomes pernicious when developments outstrip a manpower pool--again a problem in New Zealand where there has never been sufficient specialist-trained personnel to service the special education system. One must therefore be quite realistic in evaluating the system's capacity to respond to demands made upon it or tasks it may wish to undertake--a point that is particularly important to developing countries which might be comtemplating setting up a comprehensive special education system.

System Variables

The way in which the system converts inputs into outputs. This involves decision-making as to which procedures will achieve the objectives, taking account of the personnel and plant resources that are available to the system.

In the field of special education there are a host of issues in this area to resolve and keep under constant review. These in clude:

(i) curriculum design and methods (e.g., oral-aural vs manual vs total communication methods for teaching the deaf, structured vs unstructured activities for the mentally handicapped, perceptual training vs direct methods for specific learning difficulties...),

(ii) assessment methods,

(iii) social factors (e.g., integration vs segregation vs partial integration, categorisation),

(iv) appropriate staff-pupil ratios...

Output Variables

The products of the system that are sent out into the relevant environment. Questions that arise here include what is the nature of the information relating to the outputs? And is the information comprehensible to its receivers?

Here again, special education does not fare too well--at least in New Zealand. Here there is no regulations comparable to America's public law which requires teaching objectives to be specified and evaluated, the bulk of output assessment being unsystematic and more intuitive than empirical. Much of it has been conducted more out of interest on the part of academic researchers than as a result of any evaluative mechanism built into the system.

Feedback Variables

The way in which outputs are fed back, firstly to the sources of input and, secondly, to the system itself. Feedback to the former should

influence the inputs, thus adding an important dynamic component to an otherwise static model. Feedback to the system also adds dynamism to the system, this time by providing an evaluation mechanism by which the system adjusts itself to optimise the achievement of its objectives. A critical issue here is the extent to which the system actively seeks and is receptive to feedback on its own performance--in particular the extent to which it is responsive to deviation--controlling feedback (i.e., negative feedback) which informs it that goals are not being achieved by the present system operation.

In relation to specialeducation, questions that arise at this point include:

(i) What is the nature of the output information that is transmitted? Is it complete enough to be of value?

(ii) Is the output inf rmation transmitted in a form that is comprehensible to its receivers? There is little point, for example, in presenting laymen with statistical data on esoteric variables.

(iii) Are the relevant subsystems receptive to feedback? Do they have ways of processing it to enable them to modify their activities?

The Operation of the Special Education (Sub) System

The operation of the special education subsystem and its relationships to other societal structures, particularly the education system of which it is a part, was portrayed in Figure 1. We turn now to a more detailed analysis of the special education subsystem, as schematised in Figures 2 and 3. Figure 2 shows the connections between the education

system and the structures which make demands upon it and provide supports for its operation, the key structure being the legislative system which, in New Zealand, is the House of Representatives). The system's output are indicated by the arrows leaving the box on the right, some of them returning to the education system itself to provide feedback on its performance, some returning to the sources of input on the left of the diagram, and some not being noted at all.

(Place Figure 2 about here)

Figure 3 represents an enlarged and more detailed representation of the operation of the special education subsystem. In this diagram, the major sources of input into special education are:

(i) the other subsystems of the education system, the directorate subsystem playing a prominent role because of its statutory responsibility (in New Zealand) for overseeing special education;

(ii) the other systems of the child-oriented suprasystem (in New Zealand the Health and Social Welfare Departments are the most relevant systems);

(iii) the relevant environment (although a good deal of input from this source in New Zealand is channeled through the directorate subsystem of the education system, direct access is possible and is encouraged).

If one were to formalize the operation of, say, the directorate subsystem appropos the special education subsystem, the following functions would be appropriate:

(i) defining the boundaries of the special education subsystem and relevant systems and subsystems;

(ii) defining the broad goals of the special education subsystem, taking into account attitudes and constraints within the relevant environment;

(iii) developing an executive to administer the subsystem, preferably with the help of an advisory committee;

(iv) establishing efficient communication channels with the executive of the subsystem;

(v) seeking inputs from the executive of the subsystem and from other relevant sources;

(vi) responding to inputs from the executive of the subsystem and from other relevant sources;

(vii) providing resources for the subsystem's goals to be achieved.

The special education subsystem itself may contain a range of components--only three of which are portrayed in Figure 3: the teaching services, the psychological services, and parents and voluntary societies. Others which should be included are the buildings and equipment services, the psychological services, and parents and voluntary societies. Others which should be included are the buildings and equipment services, advisory services, teacher educators, and researchers. The feedback mechanism is similar to that described for Figure 2.

(Place Figure 3 near here)

Taking the executive of the special education subsystem, this time, the following functions might be educed:

(i) establishing components to achieve the broad goals of the subsystem and to implement policy;

(ii) in collaboration with each component, defining the goals for each and how they are to be elaborated;

(iii) establishing and fostering efficient communication channels with and among the components by means of regular conferences, newsletters, etc.;

(iv) establishing efficient communication channels with relevant systems and subsystems;

(v) seeking and responding to inputs into the subsystem and from the subsystem's components;

(vi) formulating proposals for new developments, with due regard to the subsystem's priorities and transmitting these to the directorate of the education system;

(vii) evaluating the efficacy and efficiency of the subsystem as a whole.

Conclusion

This paper represents an attempt to demonstrate the utility of a systems approach to the design and evaluation of special education. Its thrust is that this cannot proceed without due regard to (i) the overall structure of the system under study and its relationships with any supra-system and environment in which it is embedded, (ii) the interfaces between and the coordination of its subsystems, (iii) the ongoing evaluation of the extent to which input objectives are matched by the system's outputs, and (iv) the system's capacity to respond to feedback on its own performance. It is suggested that only a systems approach provides a sufficiently comprehensive framework for these factors to be taken into account.

To be fair, however, one must be cautious in advocating the application to education of a model derived from science and technology. As noted in a recent report, social systems differ in several important respects from technical systems (CERI, 1971, p. 38). They are, for example, more open, and elements cannot be entirely determined or controlled. Another writer has criticised what he terms "the strikingly deterministic aspect of systems management as it applies to education" (Apple, 1972, p. 12). These points are well taken, but provided one is prudent, the advantages of a systems approach far outweigh its disadvantages. In the writer's view special education ideally lends itself to the analysis and planning strategies derived from the systems approach. It is certainly far too important an enterprise not to be closely scrutinized and carefully developed.

Acknowledgement

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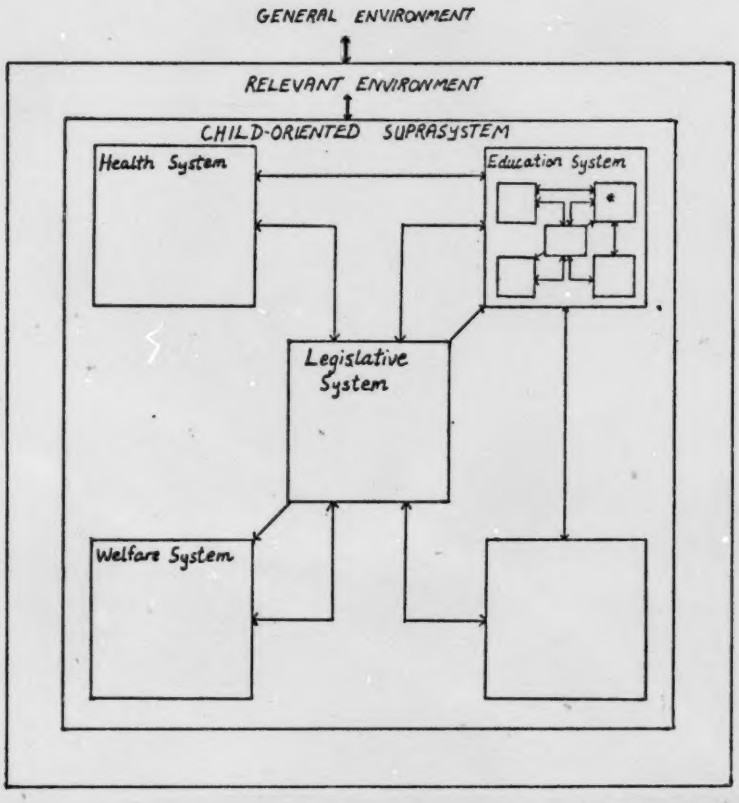

Special Education Subsystem

Fig 1 Diagrammatic representation of special education in relation to other societal structures.

Note 1. Not all connections among systems are shown.

Note 2. Not all systems are represented.

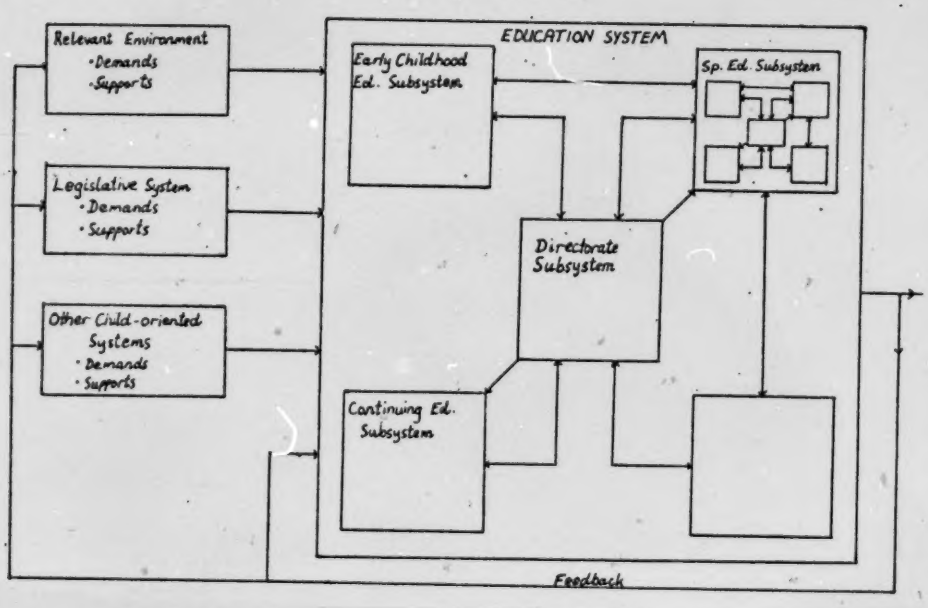

Fig 2 Diagrammatic representation of the operation of the education system.

Note 1. Not all connections among subsystems are shown.

Note 2. Not all subsystems are represented.

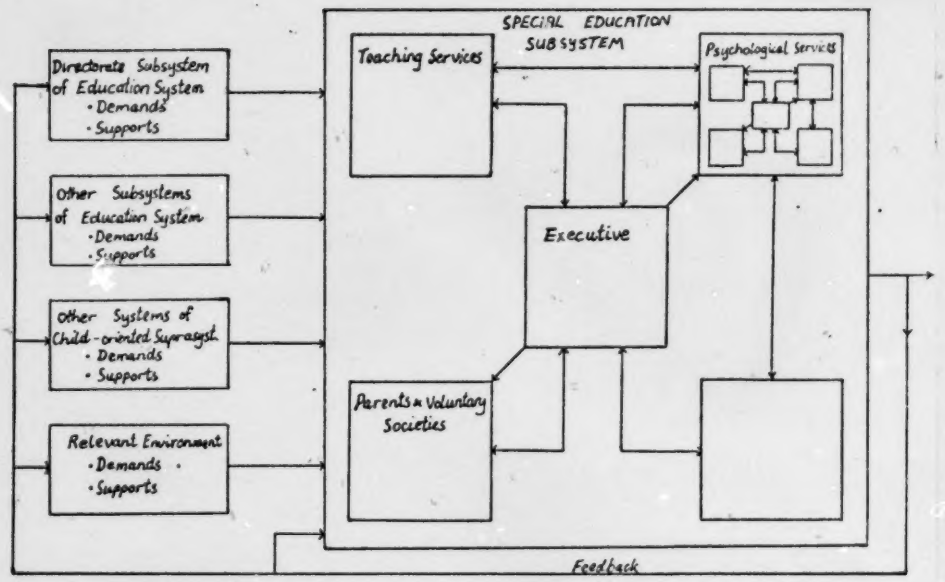

Fig 3 Diagrammatic representation of the operation of the special education subsystem of the education system.

Note 1. Not all connections among components in the subsystem are shown.

Note 2. Not all components are represented.